Traction Control for Mobility Assurance and Denial in the Urban Environment

Polymer Snow for Versatile Traction Control

Problem Overview

Special Projects Office

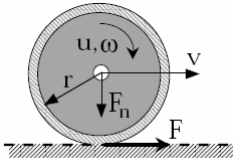
Goal: Develop a system to reversibly control mobility of the enemy through control of ground traction

person

F = μN

F: traction force
μ: coeff of friction
N: weight

vehicle



Enemy forces

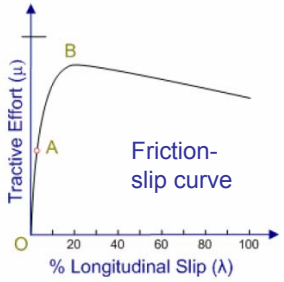
velocity

Deny

Traction control material

distance

US forces



For tires/soles

μ = 0.9 dry asphalt
μ = 0.6 wet asphalt
loose gravel
μ = 0.3 packed snow
μ < 0.1 ice

SLIP THRESHOLD
μ ~ 0.3

Traction decreases
- **For decreasing μ**
- **For increasing velocity**

- Lab measurements of μ do not correlate with real-world traction

⇨ Need real mobility testing with people/vehicles on real surfaces

Key metrics and Go/No-Go's:

1. **% increase in traversal time from Point A to Point B:** Joint Non-Lethal Weapons Directorate has CDD which states, "cause an individual to slip and fall," and "impair driver's ability to steer, stop, accelerate." *We propose practical requirement of 10-fold increase* ⇨ **QR 2-fold increase on asphalt, concrete, tile**
2. **Reversibility:** *traction restored in <0.1 sec* ⇨ **QR traction restored in 1 min**
3. **Easy clean-up:** *self-cleaning* ⇨ **QR sweep up or hose down with water**

Approach

Southwest Research Institute (SwRI) has developed a slippery film-forming polymer (SFF) system that is water-activated. Long chains coat and adhere to surface to form high viscosity slippery gel material.

Evaluated at SwRI

Pluses:

- Very slippery
- Delivery systems developed

Minuses:

- No control of slipperiness
- Not reversible
- Hard to clean up (sticks to surfaces)
- Short duration
- Large quantities of water required
- Not compatible with all surfaces

PSI, Corp. has developed a version of Polymer Snow that provides a bulk particulate slippery material that is reversed by adding a countermeasure.

Evaluate at SwRI

Pluses:

- Reversible
- Some slipperiness control
- Easy to clean up
- Compatible with all surfaces
- Degrades with UV exposure

Minuses:

- May not be slippery enough
- Large quantities of water required
- Degrades with UV exposure

Coat polymer snow with slippery film forming polymer to provide enhanced slipperiness while maintaining reversibility and easy cleanup

Evaluate at SwRI

Testing Protocols

PEOPLE

Kinematic test combines two key elements: walking + stop/start

- 20ft long x 6ft wide tracks (asphalt, concrete, tile)

Steps:

- Apply Polymer Snow [side-by-side tests against existing anti-traction material]
- Traverse track, stop-and-turn, repeat 5x
- Measure change in traversal time
- Apply countermeasure
- Repeat traversal measurements

⇦⇦ Walk tests on Polymer Snow

VEHICLES

Measure tire rolling friction on asphalt using instrumented vehicle

- 200ft long x 12ft wide track
- Quantifies tire traction

Perform ASTM standard double lane-change maneuver

- 100ft long x 24ft wide test track
- Quantifies vehicle maneuverability
- Measure change in traversal time

Steps:

- Apply Polymer Snow
- Perform test
- Apply countermeasure and repeat test

Instrumented Vehicle

Polymer Snow for Versatile Traction Control

POLYMER SNOW

Problem: Enemy personnel and vehicles can move freely in urban environments.

Solution: Enable warfighters to deny territory to our adversaries, on demand, reversibly, in a non-toxic manner. This capability will provide situational control, sustained operational tempo, and reduction in casualties.

Approach: Use an artificial polymer-based snow to provide a way of inhibiting vehicle and personnel movement by making surfaces slippery.

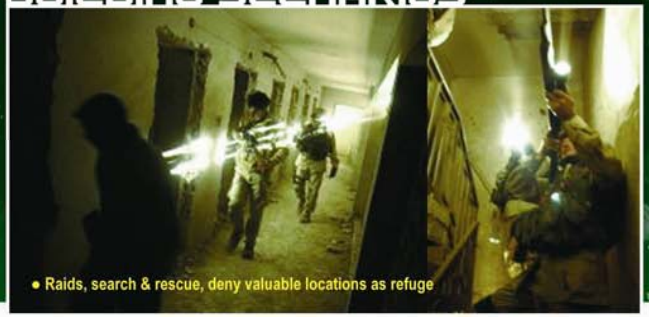
VEHICLE SCENARIO

What is Polymer Snow?
A powder that, when added to water, instantly produces a material which looks and feels like natural snow.

How does Polymer Snow Work?
The material works by modifying ground traction. Water causes the dry powder to instantly expand 100-fold to produce large volumes of slippery snow. Simple application of a non-toxic chemical treatment restores traction. The material is used in indoor snowboarding parks and for movie/television special effects.

What are the advantages of Polymer Snow?
- Can vary the traction by adjusting water content – fluffy powder to slush
- Reversible
- Compatible with most indoor and outdoor surfaces
- Easy to deliver, easy to remove (wet or dry), and reusable
- Can carry several cubic meters of snow in a briefcase
- Longer duration than current materials – does not "melt" at ambient temperatures
- Non-toxic
- Compatible with existing Marine Corps Mobility Denial System

BUILDING SCENARIOS



Program Schedule